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13 of 14

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Title: APPARATUS FOR CUTTING AND/OR WELDING THERMOPLASTICS SHEET ;

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Inventor(s): ;

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IPC Classification: B29C27/02; B26F3/14 ;

Equivalents: ;

ABSTRACT:

1528452 Seaming non-metallic sheet material; making bags; cutting by laser UNITED KINGDOM ATOMIC ENERGY AUTHORITY 26 Sept 1975 [3 Oct 1974] 39644/75 Divided out of 1528451 Headings B5K B5D and B4B Apparatus for cutting and/or welding a workpiece 10 made of thermoplastic sheet material by a laser 13, comprises a backing member 6 made of a material capable of ab- sorbing laser energy of the particular wave- length of a laser to be used, means for main- taining the workpiece in intimate thermal con- tact with the backing member, means for bring- ing radiation from the laser to a focus, and means for scanning the focused laser radiation over the workpiece. Apparatus for making plastics bags comprises a driven drum 1, Fig. 1, having dividing plates 4 forming pockets 5 spaced around the periphery of a hub 2. Alternate plates 4 are radially longer or shorter, the longer plates 4 having indentations in the outer edges thereof and the shorter plates 4 being capped with a backing material 6. Flattened tubular thermoplastic material 10, e.g. high-density polythene, is drawn from a supply by driven rollers 8a and is fed into a guide duct 9 by driven rollers 8b, the rollers 8a, 8b being driven in synchronism with the rotation of the drum 1. The drum hub 2 is perforated and suction is applied thereto by a fan 11. A laser 13 is arranged to be tracked across the end of a plate 4 therebeneath and has a power cross-section to weld and cut simul- taneously. A take-off device 15 for completed bags comprises curved steel spikes 16 and a rotating paddle 19. The duct 9 includes a device for positively directing the thermoplastic material 10 into successive pockets 5 and including a rotor 33 having twin lobes 34. Air is supplied from a plenum chamber 30 and the lobes 34 direct air first into one pocket 5 and then into a succeeding pocket 5. In operation, as each pocket 5 is presented to the duct 9, the thermoplastic material 10 is fed to form a loop 20 therein and is tensioned by the suction applied to the hub 2. The size of the loop 20 is determined by the relation of the thermoplastic material speed to the drum angu- lar velocity. The laser 13 is operated each time a shorter plate 4 lies therebeneath and may be moved physically but preferably remains sta- tionary whilst the radiation beam is moved by optical means. Due to the motion of the drum 1, the beam must have a velocity component along the length of the thermoplastic material 10 equal to the linear velocity of the relevant plate 4. To produce two bags simultaneously, Fig. 5 (not shown), cross-cuts (22) and weld seals (23) are produced on the shorter plates 4 leaving a sealed length (24) folded across each longer plate 4. The spikes 16 are forced into the folded region of each sealed length and into the in- dentations of the longer plate 4 and the sealed lengths are moved by the device 15 with the welded ends all together. When sufficient sealed lengths have been collected, they are removed, tack-welded and provided with per- forations near the folds to enadle separate bags to be torn off. To produce single bags, Fig. 6, alternate pockets 5 are wide and narrow so that long loops 20 are formed in the wide pockets only. A perforated plate 61 is preferably pro- vided near the outer end of each narrow pocket 5. If the thermoplastic material is polythene, a carbon dioxide laser having a wavelength of 10À6 microns and a power density of more than 40 wats per sq. mm. is used. The caps 6 are made of fused silica or a glass-ceramic material. A small diameter fused silica tube may be used and may be pre-heated by a resistance wire passing therethrough. A servo-control circuit, Fig. 7 (not shown), is described. In another embodiment, Fig. 8, a flattened polyethylene tube 101 passes over a fused silica rod 103 capping a plate 102 having passages 104 therein to which suction is applied by a fan 106, the suction longitudinally tensioning the tube 101. A radiation beam 109 from a carbon di- oxide laser 110 is focused by an optical system 111 to a line focus having an aspect ratio of approximately 10 : 1. The focused beam 109 is arranged to have a Gaussian energy profile so as to cut the tube 101 along the axis of the focused beam but at the edges of

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# PATENT SPECIFICATION

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(19)



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## (54) IMPROVEMENTS IN OR RELATING TO APPARATUS FOR CUTTING AND/OR WELDING THERMOPLASTICS SHEET

(71) We, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, London, a British Authority, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to apparatus for cutting and/or welding thermoplastics materials by means of lasers, and in particular to the cutting and welding of polythene sheet.

Such operations are applied when, for instance, manufacturing plastics bags from strips of plastics sheet material and there are numerous machines known in the art for manufacturing such bags. Such prior art machines typically employ a hot member, such as a hot wire or knife, which is applied to the plastics sheet material to cut and/or weld the sheet material. The prior art machines tend to have problems resulting from their complicated mechanical structure required to apply and retract the hot members to and from the plastics sheet. It is clearly a desirable that bag forming machines should operate at as high a speed possible and speeds of operation are generally restricted with prior art machines by the complicated mechanical structure and the difficulty of putting sufficient heat energy into the plastics material where it is to be welded or cut in the shortest possible time.

A commonly used powerful laser is that which uses carbon dioxide gas as the lasing medium. The radiation emitted by such lasers has a wavelength of 10.6 $\mu$m. Unfortunately most thermplastics materials do not have absorption bands in this region of their spectra. Hence operations on materials such as thin polyethylene sheets, for example, using such lasers are difficult to carry out with any degree of efficiency because the ratio of energy absorbed to energy transmitted is low.

According to the present invention there is provided apparatus for cutting and/or welding a workpiece made of laminar thermoplastic material by means of a laser, comprising at least one backing member having a high coefficient of absorption for the particular wavelength of a laser to be used to operate on a thermoplastics workpiece, a low thermal diffusivity and good resistance to thermal shock, means for maintaining the workpiece in intimate thermal contact with the backing member, means for bringing radiation from the laser to a focus in the region where the workpiece is in contact with the backing member, and means for scanning the focused laser radiation over the workpiece.

Preferably the means for focusing the beam of laser radiation is adjustable so that the position of the focused beam can be varied in relation to the workpiece and it also is such as to bring the laser beam to a line focus, and the means for causing the focused beam to traverse the workpiece is arranged so to move the focused beam that the major axis of the focal line forms a continuous line across the workpiece. Also, preferably there is provided means for applying a longitudinal tension to the workpiece the tensioning means being adjustable to enable the tension applied to the workpiece to be varied to suit the type and thickness of thermoplastics material to be operated upon, and also the operation to be performed.

By adjustment of the power level of the laser and/or the rate of scan of the focused beam across the workpiece and/or the position of focus of the laser beam in relation to the surface of the workpiece, the apparatus can be made to cut a workpiece consisting of one or more layers of thermoplastics material, weld two layers of

thermplastics material together or cut and weld two layers of thermoplastics material simultaneously, as is required in the manufacture of plastics bags.

For the welding, the laser beam is brought to a focus in the body of the workpiece and the integrated energy applied to the workpiece is controlled so that the energy dissipated in the workpiece is only sufficient to soften the workpiece, and the duration of the softening is sufficient to allow the softened material to flow together. For cutting, the laser beam is brought to a focus on the surface of the workpiece, but the integrated energy is increased so that the plastics material is vaporised along the line of cut. For cutting and welding simultaneously it is necessary to achieve both conditions at the same time. This can be done by bringing the laser beam to a line focus the energy density of which has an approximately Gaussion profile, and causing the major axis of the line to traverse the workpiece along the direction of the weld or cut.

In practice it is undesirable to vary the power level of the laser beam and the integrated energy applied to the workpiece is controlled primarily by varying the rate of scan of the laser beam across the workpiece.

In the present invention the laser energy which is transmitted through the workpiece is absorbed by the backing material, converted into thermal energy such as readily to be absorbed by the plastics material and passed back into the workpiece, thus enhancing the utilisation of the laser energy.

Although the mechanism involved in redirecting the laser energy is not yet fully understood, it is thought to include either direct conductive heat transfer from the backing member into the sheet or re-radiation of energy from the member at a shorter wavelength which is more readily absorbed in the sheet material, or to be a mixture of these two processes. In any case it has been found essential for increasing machining efficiency to ensure a firm intimate thermal contact between the sheet and the backing member.

The backing material needs to have a low thermal diffusivity so that it rapidly heats up when it is scanned by the laser beam, and the energy profile of the laser beam is not lost before the completion of the required operation. On the other hand, it is necessary for the backing member to cool below the melting point of the thermoplastics material before the next piece of workpiece is brought into contact with the backing member for the next operation to be carried out. These two requirements set the limits for the thermal diffusivity of the backing material. The coefficient of absorption of the backing member material for the laser wavelength used needs to be sufficiently high for substantially all the laser energy transmitted through the workpiece and incident upon the backing member to be absorbed in the surface region thereof, say within a depth of some 2 mm. Other properties required for the backing member material are that is should not decompose at the temperatures involved, some 1900°C for polythene as the thermoplastics material, and that it should be capable of withstanding the stresses involved in repeated cycling between this temperature and approximately 100°C.

Suitable materials for the backing member are siliceous materials such as fused silica, or possibly glass-ceramic materials. In a preferred arrangement the backing material is in the form of small diameter fused silica rods or tubes. The use of fused silica tubes as the backing material has the added advantage that a resistance wire can be passed through the tube so that it can be pre-heated.

The tension can be applied to the workpiece either pneumatically or mechanically. Whichever system is adopted, the arrangement should be such that at any line of cutting or welding, the tension in that part of the workpiece which has not been operated upon should not be effected by the operations which have been carried out on the other part of the workpiece.

The tension required is related to the thickness and nature of the thermoplastics material. In the case of polyethylene of a nominal thickness of 15 $\mu$m, the tension needs to be greater than 400 gms/metre width of workpiece.

If the operation to be carried out includes welding, then this is facilitated by having a gas pressure between the workpiece and the backing material. This can be created by gas arising from the backing material or the workpiece as a result of the temperatures involved, or it can be created by injecting a gaseous medium through perforations in the backing material, for example.

The required power rating of the laser is governed by the absorption properties of the thermoplastics material, its melting point, and also the cutting speed required. For 15 $\mu$m thick polythene, to allow a cutting and welding speed of 1000 feet per second, a power density in the focused beam of more than 40 watts/sq. mm is required. Thus if the line focus has dimensions of 10 mm by 1 mm, a 400 watt laser is required.

In a preferred application of the

invention the apparatus is adapted for manufacturing bags from a workpiece including two superimposed layers of thermoplastics material and comprises a carriage, a plurality of dividing members defining a series of spatial intervals, means for moving the carriage so as to present successively each spatial interval to a feed station including means for continuously feeding strip thermoplastics material to the carriage so that the strip material is fed into each spatial interval and over the edges of adjacent dividing members, wherein at least the edges of selected dividing members are adapted to form the backing members.

A means for applying a tension to the workpiece may comprise means for extracting air from within the spatial intervals so as to pull the strip into the spatial intervals and produce a tension in the workpiece where it extends around the edges of the dividing members.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic representation of an embodiment of the invention for making plastics bags.

Figure 2 is a view of a take-off device incorporated in the embodiment of the device shown in Figure 1.

Figure 3 illustrates in more detail a plastics material feed device incorporated in the embodiment of the invention shown in Figure 1.

Figures 4*a* to *d* illustrate the action of the component shown in Figure 3,

Figure 5 illustrates a way in which pairs of bags can be formed from a tubular strip of plastics material and

Figure 6 illustrates a way in which single bags can be formed from a tubular strip of plastics material,

Figure 7 is a block circuit diagram of a servo-control system incorporated in the embodiment of the invention shown in Figure 1 and

Figure 8 shows a cross-section of part of another apparatus for making bags.

Referring to Figure 1, a drum 1, formed by a cylindrical hub 2 and two end plates 3, of which only one is shown, has a plurality of dividing members 4 which form a series of spatial intervals, or pockets, 5 spaced around the periphery of the hub 2. The dividing members 4 are in the form of radially mounted plates, alternate plates being longer or shorter in the radial sense. The outer edges of the longer of the dividing members 4 have a number of indentations formed in them, while the shorter of the dividing members 4 are capped with a backing material 6 the purpose of which is described later. The drum 1, is rotated by an electric motor which is not shown. A feed station, indicated generally by the numeral 7, includes two pairs of driven feed rollers 8*a* and 8*b* and a guide duct 9 described in detail later. The rollers 8*a* and 8*b* are driven by electric motors, which also are not shown, and which are linked to a servo control system, to be described later, which operates also upon the motor driving the drum 1 in such a manner that a predetermined, but variable relationship can be maintained between the speed of rotation of the drum 1 and the rate of feed of a web 10 of tubular strip plastics material, to be made into bags. The rollers 8*a* pull the web 10 of feed stock material from a supply drum, which is not shown, and the rollers 8*b* feed the web 10 to the drum 1 via a guide duct 9. The strip plastics material is a flatened tube of high-density polythene. The hub of the drum 1 is perforated and a fan 11 and an associated system of ducting 12 enable an inwardly directed air pressure gradient to be maintained in each of the pockets 5. Further round in the direction of rotation of the drum 1 is a laser 13 the beam from which is arranged to be tracked across the outer edge of each of the shorter dividing members 4 as it reaches a work station. The beam from the laser 13 is arranged to have a power cross-section such that welding and cutting operations are performed simultaneously.

Further round still is a take off device 15 for removing bags which have been completed. The take-off device 15 is illustrated in figures 1 and 2. Referring to these figures, the take-off device 15 consists of a number of curved spikes 16 which are made from pointed strips 17 of steel and are so positioned as to pass through the indentations in the longer dividing members 4, previously referred to. The strips 17 have webs 18 attached to them which enable them to be attached to the rest of the apparatus. The sides of the strips 17 are sharpened in the neighbourhood of their points, and the leading edges of the webs 18 also are sharpened. Bags carried round to the take-off point are forced onto the spikes 16, and the sharpened edges cut T-shaped slots in the bag material so that the picked-off bags can travel down the spikes 16. The polythene is sufficiently rigid for the bags to stay on the spikes 16. The action of the spikes 16 is facilitated by a rotating paddle 19 driven through gearing from the drive of the drum 1.

The action of the apparatus is as follows:—

As each pocket 5 is presented to the feed station 7, a length of the web 10 is fed into and forms a loop 20. The size of the loop 20,

and hence that of the finished bag, is determined by the rate of feed of the web 10 in relation to the angular velocity of the drum 1. The formation of each loop 20 is assisted by means of the inward pressure gradient generated by the fan 11 and the ducting 12. The force exerted on the web 10 by the inward pressure gradient is greatest when it has just entered any given pocket 5 thus generating a longitudinal tension in the web 10, and decreases as the pocket 5 is filled. On the other hand the frictional force between the web 10 and the leading face of the trailing dividing member 4 which forms the pocket 5 increases as the loop 20 is formed. The formation and control of the length of the loop can be aided by means of a throttle valve 21 in the ducting 12. The differential pressure also keeps the loops 20 in position as they are carried round to the position of the laser 13 which welds and cuts the web 10. The laser 13 is operated when the shorter dividing members 4 are positioned beneath its beam position.

The manner in which two bags can be produced simultaneously is illustrated in figure 5. Cross-cuts 22 and weld seals 23 are formed on successive shorter dividing members 4 leaving a sealed length 24 of the web 10 folded across the intermediate longer dividing member 4, upon which it is carried round to the position of the take-off spikes 16. These are forced into the folded region of the sealed length 24 of the web 10, and the sealed lengths of the web 10 are picked off with the welded ends all together. When sufficient sealed lengths 24 have been collected they are removed, tack-welded together and provided with perforations near the folds to enable separate bags to be torn off.

Single bags can be made by so displacing the intermediate members 4 with relation to the adjacent dividing members 4 that alternate pockets 5 are wide and narrow, as shown in figure 6. The constant rate of feed of the web 10 will result in long loops 20 being formed in the wide pockets 5 and only short loops being formed in the narrow pockets 5, again as shown in figure 6. After the sealing and cutting of the lengths 24 of the web 10, they are removed by the take-off spikes 16 as before, and the unwanted material is cut off.

It may be advantageous to provide a perforated plate 61 near the outer end of each narrow pocket 5. The inward flow of air will press the web 10 against the plates even when the web 10 has been cut into sealed lengths 24 and so will help to prevent any tendency for the separated lengths to slip on the intermediate members 4 due to the different weights of material on each side of the intermediate members 4 before they are taken off by the spikes 16.

To achieve high rates of production it is necessary to positively direct the web 10 into successive pockets 5 instead of relying solely on the passage of the dividing members past the feed station 7.

Referring to figure 3, the feed duct 9 includes a device for positively directing the web 10 into successive pockets 5 and its action is illustrated in figures 4*a* to 4*d*. Attached to one side wall of the duct 9 is a plenum chamber 30. The passage of air from the plenum chamber 30 is controlled by a valve plate 31 and an adjustable gate 32, which forms part of the duct 9. Positioned in the path of air issuing through the valve plate 31 is a twin-lobed rotor 33 which is arranged to be driven at a rate of N/2P where N is the rate of rotation of the drum 1 and P is the number of pockets 5 in the drum 1. The radial length of the lobes 34 of the rotor 33 is such as to provide a slight overlap between their tips and the larger dividng members 4.

The drives between the drum 1 and the rotor 33 are so arranged that the lobes 34 and the dividing members 4 pass one another approximately simultaneously but without actually making contact.

In figure 4*a* the rotor 33 is shown with its lobes 34 approximately parallel to the direction of feed of the feed stock material 10. Air is able to pass from the plenum chamber 30 along one side of the rotor 33 to assist in the formation of a loop 20 of material in one particular pocket 5. Figure 4*b* shows the situation when a particular dividing member 4 has just passed a corresponding lobe 34. The slight overlap of the lobe 34 and the dividing member 4 has enabled the lobe 34 to carry the web 10 over the tip of the dividing member 4 and somewhat into the next pocket 5 to assist in the formation of a loop 20. Also, just prior to the mechanical deflection of the web 10 the movement of the rotor 33 has cut off the passage of air to the previous pocket 5 and directed it towards the succeeding pocket 5 to assist in forming the incipient loop 20. Figure 4*c* shows the situation somewhat later when the loop 20 is partly formed, and Figure 4*d* shows the situation later still. Air can now pass on both sides of the rotor 33 into the forming loop 20. And so on.

Alternatively, the web 10 of plastics material can be directed into the pockets 5 by means of suitably positioned and activated jets of air.

As the laser used is a carbon dioxide laser and the feedstock material is polythene, steps are taken to increase the absorption of energy by the polythene. This is done by using fused silica as the material from which the tips 6 are made. The silica readily

absorbs the 10.6 $\mu$m radiation from the laser which has not been absorbed by the web 10, heats up and passes thermal energy back into the web 10.

The laser 13 can be moved physically, but it is preferable to keep the laser 13 stationary and cause the beam of radiation from it to move across the feedstock material 10 by optical means. In either case, due to the motion of the drum 1 it is necessary for the laser beam to have a component of velocity along the length of the strip 10 equal to the linear velocity of the appropriate dividing member 4. This may be done by reflecting the beam from the laser 13 on to the appropriate dividing member 4 by a rotating multifaceted mirror, the axis of rotation of which is aligned at an appropriate angle to that of the drum 1.

Referring to Figure 7, the servo control system which maintains the desired relationship between the rotational speed of the drum 1 and the rate of feed of the web 10 consists of a clock pulse generator 81, a ramp generator 82 and three control loops indicated generally by the reference numberals 83, 84, and 85. The loops 83 and 84 control the drives to the feed rollers 8*a* and 8*b* and the loop 85 controls the drive to the drum 1. Each of the control loops 83, 84 and 85 includes a binary rate multiplier 86, a counter 87, a digital to analogue converter 88, a power amplifier 89 a tachometer 90, and a shaft position encoder 91. The tachometer 90 and the shaft position encoder 91 are attached to the armature of an electric motor 92 which drives the relevant part of the machine. The control loop 83 which controls the unreel roller 8*a*, also includes a ramp generator 94. The two loops 83 and 84 are governed by a set speed device 93 for setting the speed of the rollers 8*a* and 8*b* in relation to that of the drum 1. The loop 85 is governed by another set speed device 95 for setting the speed of the drum 1.

The system operates as follows:— The clock pulse generator 81 produces a sequence of regularly recurring clock pulses. The clock pulses are applied to the ramp generator 82, which varies their apparent frequency during periods of run-up and run-down of the machine to and from its working rate, and thence to the binary rate multiplier 86 of each of the control loops 83, 84, and 85.

In the case of the control loop 83, the clock pulses are applied to the rate multiplier 86 via the ramp generator 94.

The factors by which the clock pulses are multiplied are governed by the set speed devices 93 and 95 under the control of the operator of the machine. It is the relationship between these factors which determines the relationship between the rate of feed of the web 10 and the rate of rotation of the drum 1, and hence the size of the finished bags. In each of the control loops 83, 84 and 85, the pulses from the multiplier 86 are applied to the counter 87 and there compared with pulses derived from the shaft position encoder 91. The resulting difference signal is applied to the digital-to-analogue converter 88 and thence to the power amplifier 89 which drives the motor 92. Further control over the shaft speed of each motor 92 is derived from a tachometer 90 attached to the armature of the motor 92 which produces signals indicative of the shaft speed. The velocity signals also are applied to the amplifier 89.

The clock pulses from the pulse generator 81 also are applied to a separate control system 97 for controlling the operation of the laser 13, and, via two limit switches 96 to the ramp generator 94 which is included in the control loop 83. The purpose of this arrangement is to ensure that a loop lightly tensioned web material is maintained between the rollers 8*a* and 8*b*, thus ensuring that the web 10 is fed to the drum 1 in an unstressed state. The limit switches 86 enable the size of the loop to be controlled.

Referring to figure 8, a workpiece 101 consisting of a flat tube made of high density polythene of some 15 $\mu$m thickness, and which is to be made into bags is positioned over a supporting plate 102 by means of an apparatus which is not shown. The plate 102 is capped by a rod 103 which is made of fused silica. The rod 103 acts as a backing member for the workpiece 101. The plate 102 has holes 104 drilled in it which communicate with a manifold 105 and a fan 106. Operation of the fan 106 creates a pressure differential across the inner and outer surface 107, 108 respectively, of the workpiece 101, which creates a longitudinal tension in the workpiece 101 as well as causing the workpiece to become firmly attached to the plate 102. The positions of the holes 104 in the plate 102 are such that the clamping forces which maintain the tension in the workpiece 101 as well as attaching the workpiece 101 to the plate 102 are unaffected by whether or not the workpiece 101 is continuous across the top of the rod 103. Hence the tension in the workpiece 101 is unaffected as the operations of cutting and simultaneous welding of the cut ends are carried out.

A beam 109 of radiation from a carbon dioxide laser 110 passes through a focussing system 111 which brings the beam 109 to an approximately line focus which has an aspect ratio of approximately 10:1. The optical system 111 causes the beam 109 to

traverse the workpiece 101 in such a way as to trace a continuous narrow line of focused energy across the workpiece 101 at right angles to the longitudinal axis of the workpiece 101. The focus of the beam 109 as it traverses the workpiece 101 is maintained by established optical techniques which are well known to those skilled in the art and are not described herein.

The focused beam 109 is arranged to have an approximately Gaussian energy profile so that sufficient energy is supplied to cut the workpiece 101 along the axis of the focused beam 109 but at the edges of the focused beam 109 there is only sufficient energy to fuse the cut edges of the workpiece 101.

As in the embodiment previously described, the energy contained in the laser beam 109 which is not absorbed by the workpiece 101 is absorbed by the backing member rod 103 wherein it is converted into thermal energy such as to be readily absorbed by the polythene of the workpiece 101 and the thermal energy is passed back into the workpiece 101 to facilitate the cutting and welding thereof.

The low thermal diffusivity of the silica of the rod 103 ensures that it heats up rapidly to the required temperature, about 1900°C at which emits radiation covering the spectral range 1.7 to 3.4 $\mu$m which is absorbed efficiently by the polythene 101, and also that the energy profile of the beam 109 is not lost during each scan of the beam 109 across the workpiece 101 so that cutting and welding operations are carried out simultaneously to provide sealed lengths of polythene tubing to form bags.

Reference is made to our co-pending U.K. Patent Application 43027/74 (Serial No. 1,528,451), out of which the present application is divided.

WHAT WE CLAIM IS:—

1. Apparatus for cutting and/or welding a workpiece made of laminar thermoplastic material by means of a laser, comprising a backing member having a high coefficient of absorption for the particular wavelength of a laser to be used to operate or a thermoplastics workpiece, a low thermal diffusivity and good resistance to thermal shock, means for maintaining the workpiece in intimate thermal contact with the backing member, means for bringing radiation from the laser to a focus in the region where the workpiece is in contact with the backing member, and means for scanning the focused laser radiation over the workpiece.

2. Apparatus according to claim 1 for manufacturing bags from two superimposed layers of thermoplastics material, comprising a carriage, a plurality of dividing members thereon to define a series of spatial intervals, means for moving the carriage so as to present successively each spatial interval to a feed station including means for continuously feeding strip thermoplastics material to the carriage so that the strip material is fed into each spatial interval and over the edges of the dividing members, wherein at least the edges of selected dividing members are adapted to form the said backing members.

3. Apparatus according to claim 1 including a supporting plate having a plurality of passages formed therein, and means for drawing air through the passages, the passages being so disposed that when the workpiece is brought into contact with the supporting plate and air is withdrawn through the passages the pressure differential created across the workpiece both clamps the workpiece to the supporting plate and generates a tension in the workpiece.

4. Apparatus according to claim 2 including means for generating a longitudinal tension within the workpiece comprising means for extracting air from within the spatial intervals so as to pull the workpiece material into the spatial intervals and produce a tension in the workpiece where it extends around the edges of the dividing members.

5. Apparatus according to any preceding claim wherein the material of which the backing member is made is siliceous.

6. Apparatus according to claim 5 wherein the material of which the backing member is made is fused silica.

7. Apparatus according to any preceding claim wherein the means for focusing the beam of laser radiation is adapted to produce a line focus.

8. Apparatus according to claim 7 wherein the energy distribution across the focused beam is approximately Gaussian.

9. Apparatus according to claim 7 or claim 8 wherein the means for bringing the laser beam to a line focus and scanning the line focused beam across the workpiece are arranged to orient the axis of the line in the

direction in which the radiation is scanned over the workpiece and to scan the radiation over the workpiece in a direction at right angles to the longitudinal axis of the workpiece.

10 Apparatus according to claim 1 substantially as hereinbefore described.

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Agent for the Applicants.

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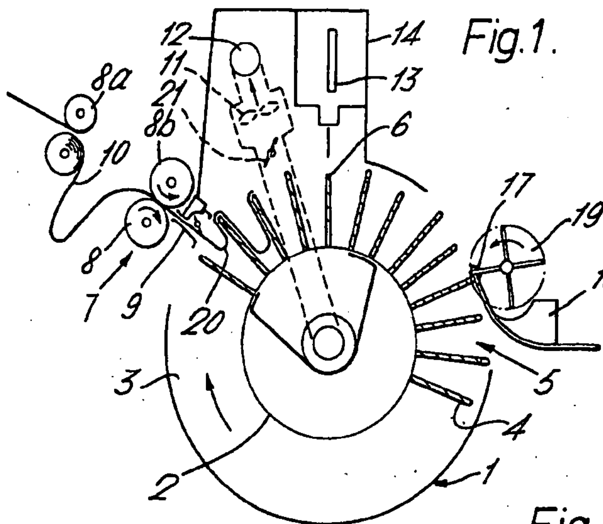



Fig.1.

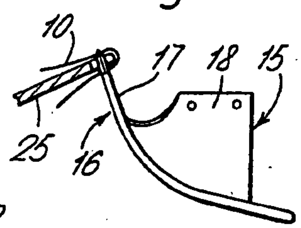



Fig.2.

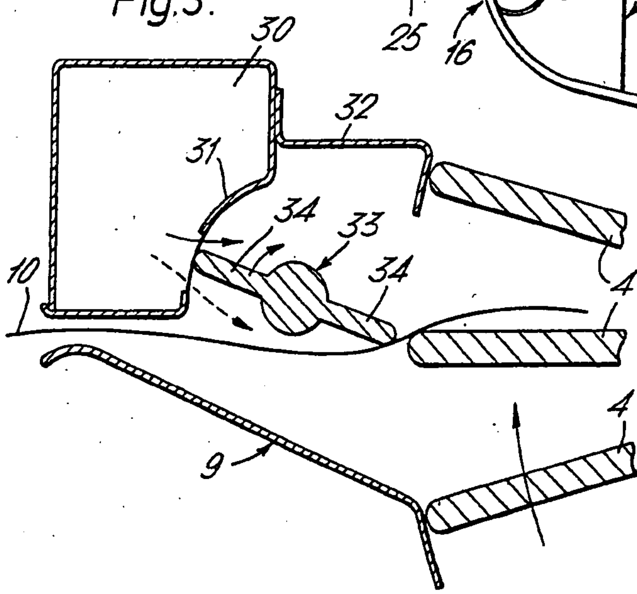
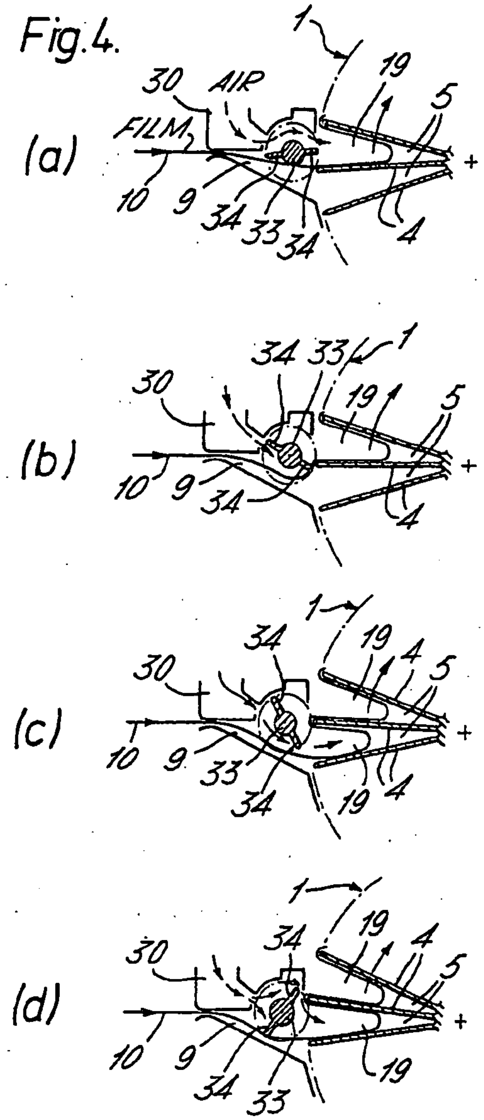



Fig.3.

Fig.4.


(a)
FILM
AIR
30
1
19
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4
10
9
34
33
34
(b)
30
34
33
1
19
5
4
10
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34
(c)
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(d)
30
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19

Fig.5.

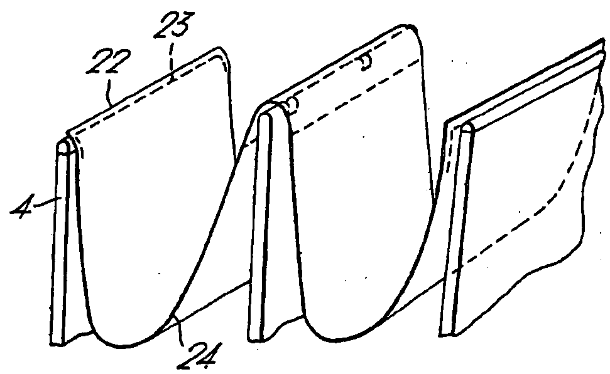
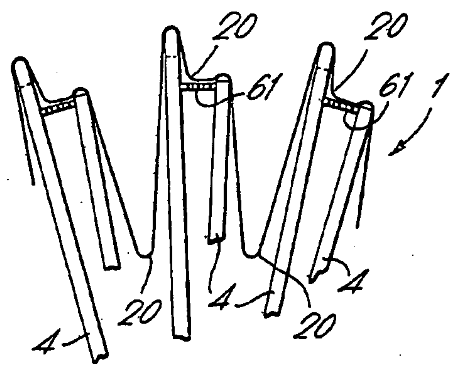
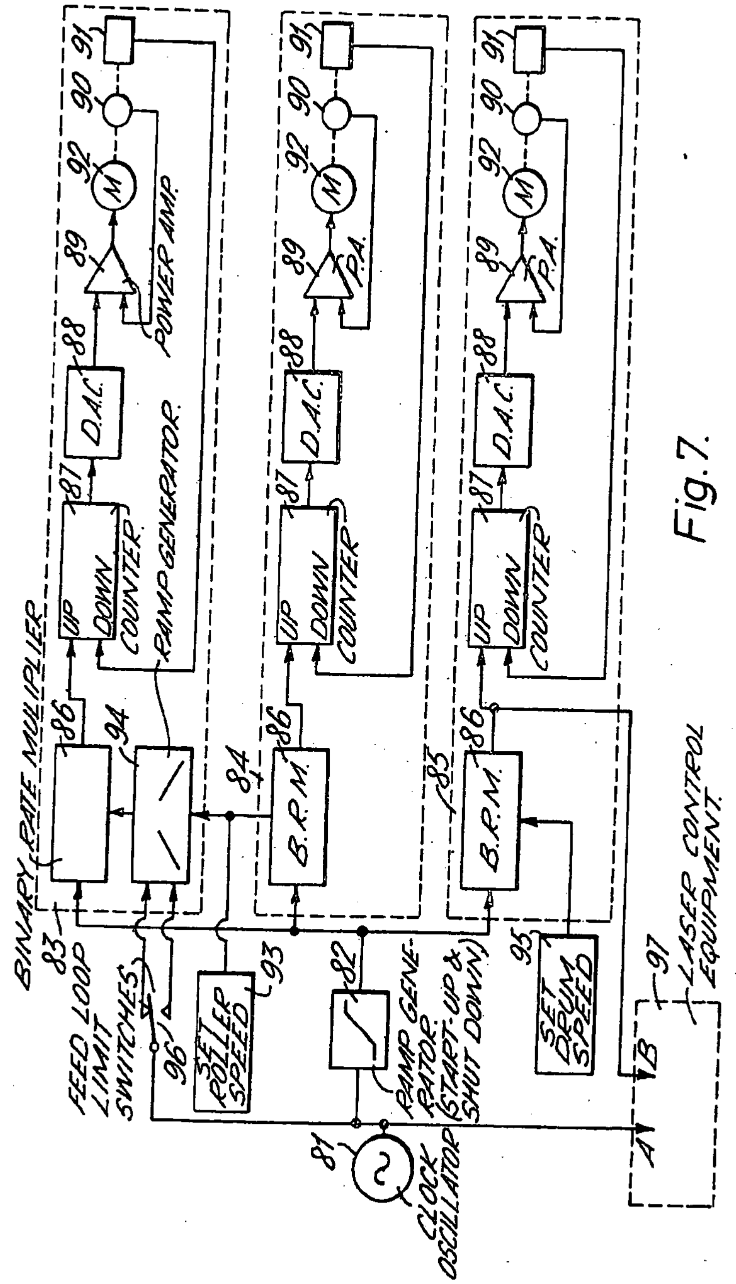



Fig.6.




BINARY RATE MULIPLIER
UP DOWN COUNTER
RAMP GENERATOR
D.A.C.
POWER AMP.
P.A.
M
B.R.M.
FEED LOOP LIMIT SWITCHES
SET ROLLER SPEED
RAMP GENERATOR (START-UP & SHUT DOWN)
SET DRUM SPEED
CLOCK OSCILLATOR
LASER CONTROL EQUIPMENT.
A
B
81
82
83
84
85
86
87
88
89
90
91
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95
96
97

Fig.7.

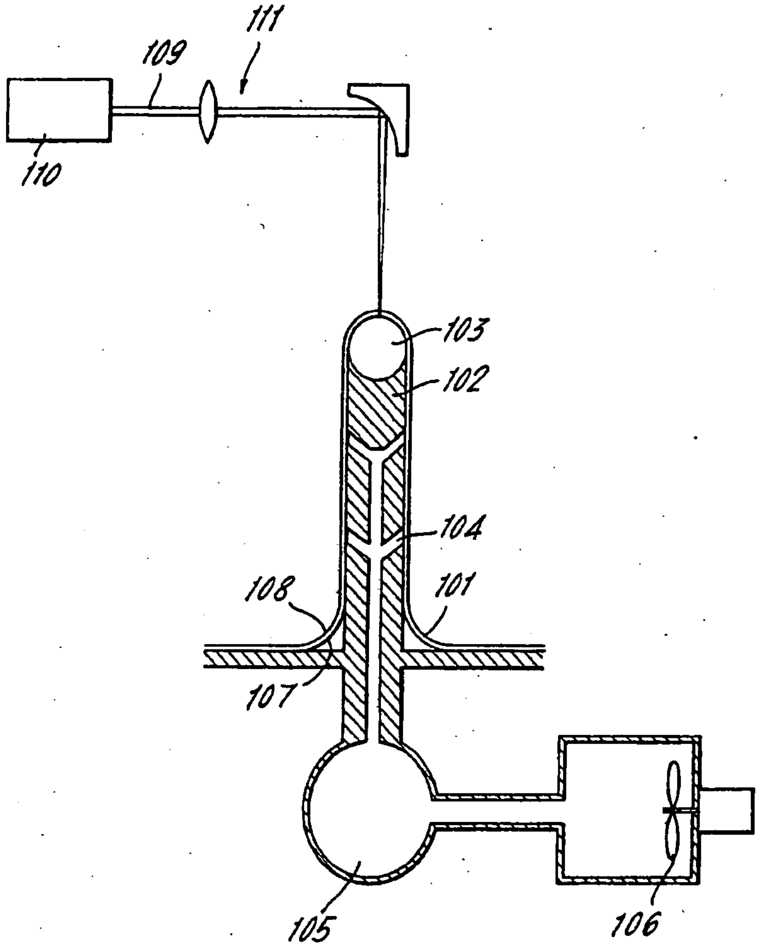


Fig. 8.

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